Thermal science laboratory (IfT)

Prof. Dr.-Ing. Jürgen Köhler

Researcher's Career

- Full Professor for Thermodynamics at Braunschweig University of Technology
- Lead Author of a RTOC/UNEP working group
- German Environmental Award 2007 of the German Environmental Foundation (DBU)
- Visiting Scientist at the Department of Mechanical Engineering of the Massachusetts Institute of Technology (MIT), USA
- Self-employed consultant engineer. Consulting work in the field of thermal sciences, air conditioning, and refrigeration
- Head of the R&D department of a manufacturer of mobile refrigeration and air conditioning systems
- Habilitation in the field of thermodynamics from Darmstadt University of Technology
- Doctoral research work and graduation (Dr.-Ing.) from Darmstadt University of Technology
- Mechanical engineering study and graduation (Dipl.-Ing.) from Darmstadt University of Technology

Funding

DFG, BMBF, BMWi, DBU, EU, Lower Saxony, industry

Contact

Technische Universität Braunschweig
Thermal science laboratory (IfT)
Hans-Sommer-Straße 5
38106 Braunschweig
Phone: +49 531 391 2625
juergen.koehler@tu-braunschweig.de
http://www.ift-bs.de/

Mission Statement

Understanding thermal energy conversion, storage, transport and interaction from the molecular to the system level is the key for developing and improving energy efficient thermal systems.

Research

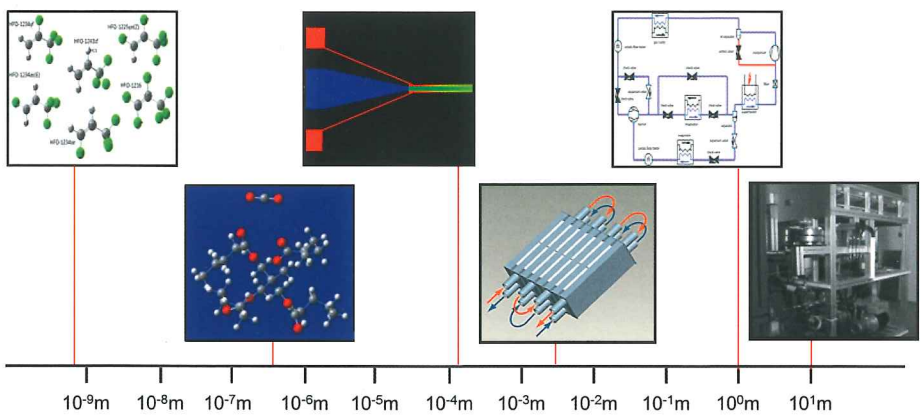
Molecular Simulation of Thermophysical Properties (Dr.-Ing. Gabriele Raabe): The research on molecular modelling and simulation is aimed at providing reliable predictions on thermophysical properties of poorly known compounds, and to gain a molecular level understanding of these properties. The studies cover various components such as novel working fluids for thermal systems, ionic liquids or drug candidates.

Dynamic System Simulation (Dr.-Ing. Wilhelm Tegethoff): High performance analysis, optimization and control of thermal systems, such as automotive thermal management systems, fuel cell systems, power plants or industrial processes. Working on international standards for the interoperability of different languages and simulators.

Refrigeration Components and Systems (Dr.-Ing. Nicholas Lemke): Experimental investigation of refrigeration components (compressor, heat exchanger, expansion device, accumulator, ...) and systems (mobile HVAC, household, residential heat supply, ...). Design and layout of test rigs. Development of complex control strategies. System analysis (measurement and simulation).

Thermal Heat Engines with Waste Heat Recovery (ORC): The good old steam engine cycle recently experiences a revival by being used for waste heat recovery in industrial and internal combustion engine processes. New approaches are used, for example to determine thermophysical properties of new working fluids and improve energy efficiency of the transient behavior of the whole cycle.

Fuel Cells, Batteries, Photovoltaic and Thermoelectric Systems: Fluxes of matter, heat and electricity can occur parallel, interact, and affect together energy conversion and storage. This is investigated with a special focus on system integration, transient behavior, and energy efficiency.



Publications

- Schulze, C.; Raabe, G.; Tegethoff, W.; Köhler, J.: Transient evaluation of a city bus air conditioning system with R-445A as drop-in – From the molecules to the system, International Journal of Thermal Sciences Volume 96, Pages 355-361, October 2015
- Smith, J.; Hinterberger, M.; Hable, P.; Köhler, J.: Simulative method for determining the optimal operating conditions for a cooling plate for lithium-ion battery cell modules, Journal of Power Sources, Volume 267, pp. 784-792, 2014
- Horst, T.; Tegethoff, W.; Eilts, P.; Köhler, J.: Prediction of dynamic Rankine Cycle waste heat recovery performance and fuel saving potential in passenger car applications considering interactions with vehicles' energy management, Journal of Energy Conversion and Management, Volume 78, pp. 438-451, 2014
- Lucas, C.; Köhler, J.: Experimental investigation of the COP improvement of a refrigeration cycle by use of an ejector, International Journal of Refrigeration, Volume 35, Issue 6, pp. 1595-1603, 2012
- Junior, C.; Chen, G.; Köhler, J.: Modeling of a new recuperative thermoelectric cycle for a tumble dryer, International Journal of Heat and Mass Transfer, Volume 55, Issues 5-6, pp. 1536-1543, 2012

Welcome to the Institut für Thermodynamik

Technische Universität Braunschweig
Prof. Dr.-Ing. Jürgen Köhler

Besides a wide range of lectures in the field of thermodynamics and heat and mass transfer, the Institut für Thermodynamik (IfT) offers its technical expertise to an interested audience in the context of research projects, seminars and software products. A variety of measuring devices, software tools as well as theoretical and experimental knowledge are available for these purposes.

The historical roots of the IfT reach back to the year 1946. Since 1998, Prof. Dr.-Ing. Jürgen Köhler has been director of the institute.

Lectures

Besides the basic courses ,,Thermodynamics'' and ,,Heat and Mass Transfer'', the IfT offers a variety of courses in both summer and winter semester.

Thermodynamics (Köhler, WS, 6 CP)
Balance and conversation laws, thermodynamic relations, fundamental equations and equations of state, heat and work interactions, equilibrium criteria, ideal gas, properties of real substances, thermodynamic processes, moist air processes.

Heat and Mass Transfer (Köhler, SS, 5 CP)
Heat exchanger, steady state and transient heat conduction, convective heat transfer with/without phase change, radiation of black/real bodies, mass diffusion.

Thermodynamics of Mixtures (Raabe, WS, 5 CP)
Basics of multicomponent systems (Gibbs fundamental and Gibbs-Duhem's equation, Lengendre transformation, equilibrium conditions and stability); properties of mixtures; thermodynamic models; phase diagrams; chemical reactions and combustion processes.

Thermodynamics and Statistics (Köhler, SS, 5 CP)
Balance and conservation laws (mass, momentum, energy, entropy), thermodynamic relations, fundamental equations and equations of state, heat and work interactions, equilibrium criteria, ideal gas, properties of real substances, statistical thermodynamics, partition functions, ensembles, relationship between microscopic and macroscopic properties intermolecular forces, applications for solid, ideal gases and real substances.

Molecular Simulation (Raabe, SS, 5 CP)
Basics of statistical mechanics and molecular modeling; introduction to Monte Carlo and molecular dynamics, simulation in various ensembles; simulation structure.

Refrigeration and Mobile Air Conditioning (Köhler/Lemke, WS, 5 CP)
Historical background, refrigeration processes, cooling circuit and mobile air conditioning refrigerants (conventional + alternatives), components (e.g heat exchangers, expansion valve, compressors, control units), basic processes (e.g Evants-Perkins-process, absorption, refrigerant processes, gas refrigerant processes).

Object-Oriented Methods in Thermal Engineering (Köhler/Tegethoff, SS/WS, 5 CP)
Intensive C++ course (classes, inheritance, polymorphism, container types). Object-oriented formulation of heat transport mechanisms (conduction, convection, radiation, contact, enthalpy flow). Transient and steady state systems.

Modeling of thermal systems with Modelica (Köhler/Tegethoff, SS/WS, 5 CP)

Object-oriented and equation-based formulation of linear DAE Systems (Differential Algebraic Equation Systems). Discussion of the basic concepts of Modelica. Modeling examples.

Further information about the current courses are available on our website: ,,Lehrangebot" – ,,Lehrveranstaltungen im aktuellen Semester".

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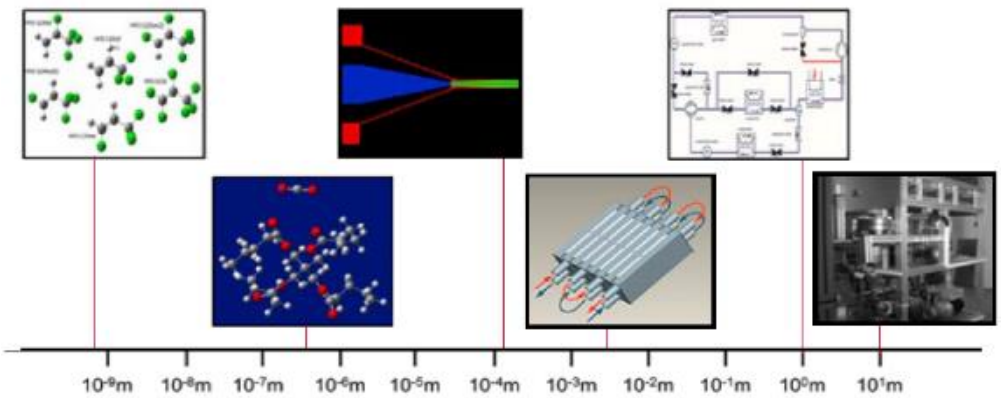


Service

The service at the IfT cover measurement, computer simulation, software, consulting and training. For further information please contact Dr.-Ing. Wilhelm Tegethoff or Dr.-Ing. Nicholas Lemke.

Measurement
For steady state and transient measurements, numerous test rigs are available such as:

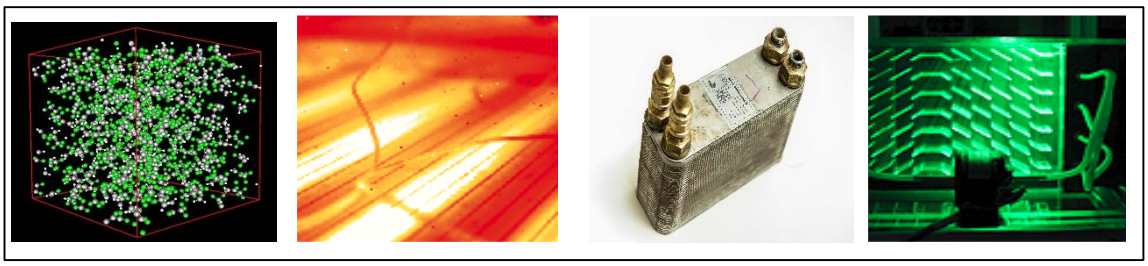
- Calorimetric test rig for air conditioning and heat pump systems and their components.
- Test rig for R134a, R1234yf TXV and R744 valves.
- Test rig for R744 accumulators including a glass accumulator for measurements of refrigerant flow rates.
- Test rig for compressors (R134a, R1234yf, R744) measurement of efficiencies and indicator diagrams.
- Test rig for condensers and evaporators with detailed online analysis of refrigerant mass distribution.
- Thermal imaging with high temperature resolution.
- Investigation of heat transfer with ammonia absorption method (AAM).

Software
In cooperation with the TLK-Thermo GmbH, IfT offers the following software products:

- TIL: Advanced Modelica library for steady-state and transient simulation of fluid systems such as heat pump, a/c, refrigeration or cooling systems.
- TILMedia: Interface library to provide fluid properties from various existing fluid and solid property databases like the IfT Library, Refprop or FluiEXL to different applications.

Training
The IfT offer partly in cooperation with the TLK-Thermo GmbH - the training courses listed below:

- Modelica introduction: Two days training for learning basic and advanced object oriented modeling of thermal systems using Modelica. Please have s look on our web site for the next course dates.
- Modelica & TIL: Training on mobile air conditioning systems with the Modelica library TIL. The next course dates are available on our web site.
- Vehicle air conditioning: Basic structure of refrigeration and cooling systems. Discussion of current issues such as refrigerants and alternative applications.



In addition, the following software are used at IfT:

- ANSYS/FLUENT, DL-Poly, Gaussian, gOpenMol, LabVIEW, MATLAB/Simulink, Modelica/Dynmola, Modelica/SimulationX, openFOAM, TINKER, TISC Software Paket, TOWHEE, …